RENNERT BILINGUAL

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This is to certify that the attached translation is an accurate, true and complete translation from Japanese into English of **Japanese patent application publication number 4-49844 concerning a DC-DC converter,** to the best of my knowledge and belief.

RENNERT BILINGUAL TRANSLATIONS

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SWORN TO AND SUBSCRIBED
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SPECIFICATION

1. TITLE OF THE INVENTION

DC-DC Converter

2. CLAIMS

[1] A DC-DC converter, wherein said DC-DC converter possesses a main circuit in which a series circuit with a switching means (Q), inductance (L) and capacitor (C) is connected to a direct current input power source and in which the voltage from both terminals of the capacitor (C) is outputted as direct current output voltage (V_0), and said converter possesses a control circuit (R) to control the switching means (Q) to which the direct current output voltage (V_0) and the standard voltage (V_S) are impressed to set and hold the duty ratio ($\Delta T/T$) for the switching means (Q) in response to the deviation voltage (ΔV), wherein a fly wheel circuit (F) is interposed between the primary side of the inductance (L) and the secondary side of the capacitor (C) comprising a parallel circuit and series circuit including an inductance (SR) with rectangular magnetic characteristics connected to the primary side of the inductance (L), a diode (D_2) connected to the inductance (SR), and a second switching means (Q_2), wherein a circuit (K) used to start the fly wheel circuit is disposed in the fly wheel circuit (F) in which the secondary capacitor (C_2) is charged in response to the switching means (Q) closing the circuit with the control electrode of the second

switching means (Q_2) connected to the secondary side of the capacitor (C) and in which voltage is generated briefly caused by the change in the current in the inductance (SR) in response to the second switching means (Q_2) opening the circuit or the switching means (Q) opening the circuit, with the second capacitor (C_2) storing the charge connected to the control electrode of the second switching means (Q_2) and the second switching means (Q_2) closing the circuit, and wherein the fly wheel circuit (F) releases the stored energy in the inductance (L) to the load in response to the switching means (Q) opening the circuit.

[2] The DC-DC converter in Claim [1], wherein the inductance (SR) with rectangular magnetic properties is a saturable reactor.

[3] The DC-DC converter in Claim [1] or Claim [2], wherein the circuit (K) used to start the fly wheel circuit possesses a series circuit with a diode (D_1) and second capacitor (C_2) connected to the primary side of the inductance (L) and the secondary side of the capacitor (C) which is controlled by the voltage on the primary side of the inductance (L) and the inductance (SR) with rectangular magnetic characteristics connected between the primary side of the secondary capacitance (C_2) and the secondary side of the capacitor (C), and wherein a third switching means (Q_3) is connected to the control electrode of the second switching means (Q_2) on the primary side thereof.

3. DETAILED DESCRIPTION OF THE INVENTION

(Industrial Field of Application)

[01] The present invention pertains to an improved DC-DC converter. More specifically, the present invention pertains to an improved fly wheel circuit. Even more specifically, the present invention pertains to an improved fly wheel circuit in a DC-DC converter that does not cause power loss and that does not cause time lag in the operation of the fly wheel.

Prior Art

[02] A simplified block diagram of an example of a prior art DC-DC converter is shown in FIG 4.

FIG 4

[03] In this figure, Q denotes a switching means such as a p-channel enhancement field-effect transistor, L denotes the inductance, and C denotes the capacitor. The direct current input voltage V_I is inputted to the switching means Q on the primary side and to the capacitor C on the secondary side. Voltage V_0 is outputted from both terminals of the capacitor C as the direct current output voltage V_0. In the figure, R denotes the control circuit. The direct current output voltage V_0 and a standard voltage V_S are inputted to the control circuit in order to determine the deviation voltage ΔV. The duty ratio $\Delta T/T$ is set so that the deviation voltage ΔV becomes zero. (See FIG 2.) The on-off operation of the switching means Q is controlled so that the duty ratio $\Delta T/T$ is attained. In the figure, D_3 denotes the fly wheel diode. The energy stored in the inductance L when the switching means Q closes the

circuit is released to the load when the switching means Q opens the circuit.

[04] The DC-DC converter shown in FIG 5 was developed in order to respond to power loss caused by forward-direction voltage drops in the fly wheel diode FD_3.

FIG 5

[05] The configuration differs from FIG 4 in that a switching means Q_4 such as an n-channel enhancement field-effect transistor is used for the fly wheel instead of the fly wheel diode D_3. Signals generated by the control circuit R are impressed to the fly wheel diode Q_4, which performs the opening-closing operation that is the opposite of the operation performed by the switching means Q. When the switching means Q opens the circuit, the fly wheel diode Q_4 closes the circuit. When the switching means Q closes the circuit, the fly wheel diode Q_4 opens the circuit thereby operating the fly wheel.

(Problem Solved by the Invention)

[06] The improved DC-DC converter in FIG 5 eliminates the forward-direction diode voltage drop problem exhibited by the DC-DC converter in FIG 4. However, it is not easy to smoothly synchronize the process of opening the circuit at switching means Q while closing the circuit at switching means Q_4. A circuit cannot be designed to make the transition simultaneously. A complicated circuit has to be used because of the difficulty of determining the operational time lag based on the stored load at switching means Q. Even so, the complicated circuit cannot

effect a completely smooth simultaneous transition between the two switching means.

[07] The purpose of the present invention is to solve this problem by providing a DC-DC converter that uses a fly wheel circuit with a switching means such as a field-effect transistor instead of a fly wheel diode. In other words, the present invention provides a DC-DC converter that is able to smoothly and simultaneously operate the switching means for the main circuit and the switching means for the fly wheel circuit.

(Means of Solving the Problem)

[08] The present invention is a DC-DC converter, wherein the DC-DC converter possesses a main circuit in which a series circuit with a switching means (Q), inductance (L) and capacitor (C) is connected to a direct current input power source and in which the voltage from both terminals of the capacitor (C) is outputted as direct current output voltage (V_0), and the converter possesses a control circuit (R) to control the switching means (Q) to which the direct current output voltage (V_0) and the standard voltage (V_S) are impressed to set and hold the duty ratio ($\Delta T/T$) for the switching means (Q) in response to the deviation voltage (ΔV), wherein a fly wheel circuit (F) is interposed between the primary side of the inductance (L) and the secondary side of the capacitor (C) comprising a parallel circuit and series circuit including an inductance (SR) with rectangular magnetic characteristics connected to the primary side of the inductance (L), a diode (D_2) connected to the inductance (SR), and a second switching means (Q_2), wherein a circuit (K) used to start the fly wheel circuit is disposed in

the fly wheel circuit (F) in which the secondary capacitor (C_2) is charged in response to the switching means (Q) closing the circuit with the control electrode of the second switching means (Q_2) connected to the secondary side of the capacitor (C) and in which voltage is generated briefly caused by the change in the current in the inductance (SR) in response to the second switching means (Q_2) opening the circuit or the switching means (Q) opening the circuit, with the second capacitor (C_2) storing the charge connected to the control electrode of the second switching means (Q_2) and the second switching means (Q_2) closing the circuit, and wherein the fly wheel circuit (F) releases the stored energy in the inductance (L) to the load in response to the switching means (Q) opening the circuit. The circuit (K) used to start the fly wheel circuit possesses a series circuit with a diode (D_1) and second capacitor (C_2) connected to the primary side of the inductance (L) and the secondary side of the capacitor (C) which is controlled by the voltage on the primary side of the inductance (L) and the inductance (SR) with rectangular magnetic characteristics connected between the primary side of the secondary capacitance (C_2) and the secondary side of the capacitor (C), and wherein a third switching means (Q_3) is connected to the control electrode of the second switching means (Q_2) on the primary side thereof.

(Operation)

[09] The DC-DC converter of the present invention possesses a fly wheel circuit F with a parallel circuit for the switching means Q_2 such a field-effect transistor and the diode D_2 as well as a series circuit for the saturable reactor SR such as an inductance with rectangular magnetic characteristics. A series circuit with a second capacitor (C_2) and a

diode (D_1) connected between the primary side of the inductance (L) and the secondary side of the capacitor (C) is interposed between the primary side of the second capacitor (C_2) and the secondary side of the capacitor (C). It is controlled by the voltage from the primary side of the inductance (L) and the inductance (SR) with rectangular magnetic characteristics. The circuit K used to start the fly wheel circuit possesses a third switching means (Q_3) which is connected to the control electrode of the second switching means (Q_2) on the primary side. When the switching means Q of the main circuit closes the circuit, the second switching means Q_2 of the fly wheel circuit opens the circuit and the second capacitor C_2 is charged during this period. When the switching means Q of the main circuit opens the circuit, the voltage is briefly generated by the change in the current beginning to flow to the saturable reactor SR (e.g. an inductance with rectangular magnetic characteristics). The charged second capacitor C_2 is connected to the second switching means Q_2 which closes the circuit and operates the fly wheel F. When the switching means Q for the main circuit is closed, the second switching means Q_2 opens the circuit and the operation of the fly wheel circuit F is terminated.

(Preferred Embodiments of the Invention)

[10] The following is an explanation of two preferred embodiments of the DC-DC converter in the present invention with reference to the drawings.

<u>1st Preferred Embodiment</u>

[11] FIG [1] is a simplified block diagram of the DC-DC converter in the first preferred embodiment of the present invention.

[12] In this figure, Q denotes a switching means such as a p-channel enhancement field-effect transistor, L denotes the inductance, and C denotes the capacitor. The direct current input voltage V_I is impressed to the switching means Q on the primary side and the capacitor C on the secondary side. Voltage V_0 is outputted from both terminals of the capacitor C as the direct current output voltage V_0. In the figure, R denotes the control circuit. The direct current output voltage V_0 and a standard voltage V_S are inputted to the control circuit in order to determine the deviation voltage ΔV. The duty ratio $\Delta T/T$ is set so that the deviation voltage ΔV becomes zero. (See FIG 2.) The on-off control of the switching means Q is controlled so that the duty ratio $\Delta T/T$ is attained. The key components in the present invention include the fly wheel circuit F and the circuit K used to start the fly wheel circuit. The fly wheel circuit F consists of a parallel circuit and series circuit with a second switching means Q_2 and a diode D_2 connected to the inductance SR. The inductance SR, which is connected to the primary side of inductance L, has rectangular magnetic properties. The series circuit is connected to a secondary capacitor C_2 and a diode D_1 which is, in turn, connected to the inductance L on the primary side and the capacitor C on the secondary side. This series circuit is connected between the primary side of the capacitor C_1 and the secondary side of the capacitor C. The series circuit is controlled by the voltage on the primary side of the inductance L and by the inductance SR possessing rectangular magnetic properties. The circuit K used to start the fly wheel circuit possesses a third switching means Q_3 in which the primary side is connected to the control electrode on the second switching means Q_2.

FIG 2

[13] The following is an explanation of the operation of the DC-DC converter in the first preferred embodiment of the present invention shown in FIG 1 with reference to the timing chart shown in FIG 2.

[14] When the switching means Q for the main circuit is closed, the direct current input voltage V_I is impressed to the load at the capacitor C via inductance L. (In the preferred embodiment, the switching means is a p-channel enhancement field-effect transistor.) The capacitor C is charged and the direct current output voltage V_0 is applied to the load. The direct current output voltage V_0 is also impressed to the control circuit R, where it is compared to the standard voltage V_S. The duty ratio $\Delta T/T$ is determined based on the deviation voltage ΔV. The switching means Q of the main circuit is controlled so that the circuit is closed at ΔT and [opened] at $T-\Delta T$, and a direct current output voltage V_0 equal to the standard voltage V_S is supplied to the load.

[15] Because a positive voltage is impressed to the base of the npn transistor Q_3 to close the circuit while the switching means Q of the main circuit is closed, the second switching means Q_2 in the fly wheel circuit F is also closed and the fly wheel circuit F is cut off from the electric current. (In the preferred embodiment, the switching means is an n-channel enhancement field-effect transistor.) During this period, however, the second capacitor C_2 is charged.

[16] Next, when the control circuit R is operated during period ΔT and the switching means Q for the main circuit opens the circuit, the load stored in the capacitor C and the energy stored magnetically in the inductance L are released, and the direct current output is supplied.

[17] Because the potential on the primary side of the inductance L (denoted by point A in the figure) drops at this time, current begins to flow through the diode D_2 and the inductance SR with rectangular magnetic properties. (In the preferred embodiment, this inductance is a saturable reactor.) However, because the inductance with rectangular magnetic properties SR briefly functions as a large inductance and generates voltage in the reverse direction, the potential at point A briefly becomes negative. As a result, the npn transistor Q_3 closes the circuit and the positive potential of the second capacitor C_2, which was already storing a charge, is impressed to the gate of the second switching means Q_2. The second switching means Q_2 turns on the fly wheel circuit F, and the energy stored in the inductance L is released by means of the fly wheel circuit F. It remains in this state until the npn transistor Q_3 closes the circuit.

[18] The inductance SR with the rectangular magnetic characteristics is saturated by a small amount of current. It then functions as an inductance so that power loss does not occur in the fly wheel circuit F.

[19] When the switching means Q is open, the fly wheel circuit F remains on by means of the diode D_2 even if the second switching means Q_2 is open. This increases the reliability of the device.

[20] The resistance R_1, R_2, R_3 adjusts the electric current, but the resistance is not critically important to the operation of the circuit. The diode D_4 is the only means of protection, but the diode does not have a significant effect on the operation of the circuit.

[21] When the time T has elapsed, the switching means Q closes the circuit again and the device returns to its initial state. However, the second switching means Q_2 is still closed. Because the inductance value of the inductance SR with rectangular magnetic characteristics is large when the direction of the electric current is reversed, voltage is generated from both terminals of the inductance SR with rectangular magnetic characteristics and the potential at point A rises. At this time, positive voltage is impressed to the base of the npn transistor Q_3 and the second switching means Q_2 is opened by the closing of the npn transistor Q_3. When the npn transistor Q_3 is closed, a slight time lag occurs until the second switching means Q_2 is closed. However, this time lag is not a problem because the inductance SR with rectangular magnetic properties prevents all but a small amount of current from reaching the second switching means Q_2.

[22] As explained above, the switching means Q for the DC-DC converter shown in FIG 1 automatically opens and closes the fly wheel circuit F. As a result, the fly wheel begins operation as soon as the switching means Q closes the circuit without any forward-direction loss in the fly wheel circuit F.

2nd Preferred Embodiment

FIG 3

[23] This preferred embodiment differs from the preferred embodiment in FIG 1 in that a negative potential is maintained at the gate of the second switching means Q_2 in the fly wheel circuit F when the switching means Q has closed the circuit. The second switching means Q_2 then opens the circuit. When the switching means Q has opened the circuit, the potential in the second capacitor C_2 is impressed to the gate of the second switching means Q_2 in the fly wheel circuit F. The switching means Q_3 which closes the circuit is an n-channel enhancement field-effect transistor. This requires only a minor change. In every other respect, the preferred embodiment is identical.

(Effect of the Invention)

[24] As explained above, the DC-DC converter of the present invention possesses a main circuit in which a series circuit with a switching means, inductance and capacitor is connected to a direct current input power source and in which the voltage from both terminals of the capacitor is outputted as direct current output voltage, and the converter possesses a control circuit to control the switching means to which the direct current output voltage and the standard voltage are impressed to set and hold the duty ratio for the switching means in response to the deviation voltage, wherein a fly wheel circuit is interposed between the primary side of the inductance and the secondary side of the capacitor comprising a parallel circuit and series circuit including an inductance with rectangular magnetic characteristics connected to the primary side of the inductance, a diode connected to the inductance, and a second switching means, wherein a circuit used to

start the fly wheel circuit is disposed in the fly wheel circuit in which the secondary capacitor is charged in response to the switching means closing the circuit with the control electrode of the second switching means connected to the secondary side of the capacitor and in which voltage is generated briefly caused by the change in the current in the inductance in response to the second switching means opening the circuit or the switching means opening the circuit, with the second capacitor storing the charge connected to the control electrode of the second switching means and the second switching means closing the circuit, and wherein the fly wheel circuit releases the stored energy in the inductance to the load in response to the switching means opening the circuit. As a result, the present invention provides a DC-DC converter that is able to operate the switching means for the main circuit and the switching means for the fly wheel circuit smoothly and simultaneously without a loss of forward-direction voltage in the fly wheel diode.

4. BRIEF EXPLANATION OF THE DRAWINGS

FIG 1 is a simplified block diagram of the DC-DC converter in the first preferred embodiment of the present invention.

FIG 2 is a timing chart used to explain the operation of the DC-DC converter in the first preferred embodiment of the present invention.

FIG 3 is a simplified block diagram of the DC-DC converter in the second preferred embodiment of the present invention.

FIG 4 is a simplified block diagram of a prior art DC-DC converter.

FIG 5 is a simplified block diagram of an improved prior art DC-DC converter.

Q ... switching means for the main circuit

L ... inductance of the main circuit

C ... capacitor of the main circuit

V_I ... direct current input voltage for the main circuit

V_O ... direct current output voltage for the main circuit

R ... set voltage control device for the main circuit

V_S ... standard voltage for the main circuit

ΔV ... deviation voltage for the main circuit

T ... chopper control time for the main circuit

ΔT ... [pass] time for the main circuit

F ... fly wheel circuit

SR ... inductance with rectangular magnetic properties for the fly wheel circuit (saturable reactor)

Q_2 ... second switching means for the fly wheel circuit

D_2 ... diode for the fly wheel circuit

K ... circuit used to start the fly wheel circuit

C_2 ... second capacitor for the circuit used to start the fly wheel circuit

D_1 ... diode for the circuit used to start the fly wheel circuit

Q_3 ... third switching means for the circuit used to start the fly wheel circuit

R_1, R_2, R_3 ... current-limiting resistance for the circuit used to start the fly wheel circuit

D_4 ... diode for protecting the circuit used to start the fly wheel circuit

A ... point on the primary side of the inductance L of the main current

D_3 ... fly wheel diode for the prior art DC-DC converter

Q_4 ... n-channel enhancement field-effect transistor in the fly wheel circuit of the prior art DC-DC converter

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FIG 1

R ... control circuit

FIG 2

Q_1 current

Q_3 On/Off

Q_2 On/Off

C_2 voltage

A-point potential

SR current

FIG 3

R ... control circuit

FIG 4

R ... control circuit

FIG 5

R ... control circuit

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㉔発明の名称　DC−DCコンバータ

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明細書

1. 発明の名称

DC−DCコンバータ

2. 特許請求の範囲

〔1〕スイッチング手段（Q）とインダクタンス（L）とキャパシタ（C）との直列回路が、直流入力電源に接続されてなり、前記キャパシタ（C）の両端の電圧を直流出力電圧（V_o）として出力する主回路を有し、前記直流出力電圧（V_o）と基準電圧（V_r）とを入力されて、その偏差電圧（ΔV）に応答して前記スイッチング手段（Q）のデューティ比（ΔT/T）を決定し、該デューティ比（ΔT/T）をもって前記スイッチング手段（Q）を制御する制御回路（R）を有するDC−DCコンバータにおいて、

前記インダクタンス（L）の一次側と前記キャパシタ（C）の二次側との間には、前記インダクタンス（L）の一次側に接続される角形磁化特性を有するインダクタンス（SR）と該インダクタンス（SR）と接続されるダイオード（D_2）と第2のスイッチング手段（Q_2）との並列回路との直列回路よりなるフライホイール回路（F）が設けられ、

該フライホイール回路（F）には、前記スイッチング手段（Q）の開閉に応答して、第2のキャパシタ（C_2）を充電するとゝもに、前記第2のスイッチング手段（Q_2）の制御電極を前記キャパシタ（C）の二次側と接続して、前記第2のスイッチング手段（Q_2）を開閉し、また、前記スイッチング手段（Q）の開閉に応答して、前記インダクタンス（SR）に流れる電流の変化に起因して瞬間的に発生する電圧をもって、前記充電されている第2のキャパシタ（C_2）を前記第2のスイッチング手段（Q_2）の制御電極に接続して、前記第2のスイッチング手段（Q_2）を開閉する、フライホイール回路起動用回路（K）が設けられてなり、

前記スイッチング手段（Q）の開閉に応答して、前記フライホイール回路（F）は、前記インダクタンス（L）の蓄積エネルギーを負荷に放出する

TL-00992

本発明の目的は、この欠点を解消することにあり、フライホイールダイオードに替えて電界効果トランジスタ等のスイッチング手段よりなるフライホイール回路が使用されるDC－DCコンバータにおいて、主回路用のスイッチング手段の動作とフライホイール回路用のスイッチング手段の動作とがスムーズに同期的に移行するように改良されているDC－DCコンバータを提供することにある。

〔課題を解決するための手段〕

上記の目的は、スイッチング手段（Q）とインダクタンス（L）とキャパシタ（C）との直列回路が、直流入力電源に接続されており、前記のキャパシタ（C）の両端の電圧を直流出力電圧（V_o）として出力する主回路を有し、前記の直流出力電圧（V_o）と基準電圧（V_s）とを入力されて、その偏差電圧（ΔV）に応答して前記のスイッチング手段（Q）のデューティ比（ΔT／T）を決定して、このデューティ比（ΔT／T）をもって前記のスイッチング手段（Q）を制御する制御回路（R）を有するDC－DCコンバータにおいて、前記のインダクタンス（L）の一次側と前記のキャパシタ（C）の二次側との間に、前記のインダクタンス（L）の一次側に接続される角形磁化特性を有するインダクタンス（SR）とこのインダクタンス（SR）と接続されるダイオード（D_1）と第2のスイッチング手段（Q_1）との並列回路との直列回路よりなるフライホイール回路（F）が設けられており、このフライホイール回路（F）には、前記のスイッチング手段（Q）の開路に応答して、第2のキャパシタ（C_1）を充電するとともに、前記の第2のスイッチング手段（Q_1）の制御電極を前記のキャパシタ（C）の二次側と接続して、前記の第2のスイッチング手段（Q_1）を開路し、また、前記のスイッチング手段（Q）の閉路に応答して、前記のインダクタンス（SR）に流れる電流の変化に起因して瞬間的に発生する電圧をもって、前記の充電されている第2のキャパシタ（C_1）を前記の第2のスイッチング手段（Q_1）の制御電極に接続して、前記の第2のスイッチング手段（Q_1）を閉路する、フライホイール回路起動用回路（K）が設けられており、前記のスイッチング手段（Q）の開路に応答して、前記のフライホイール回路（F）は、前記のインダクタンス（L）の蓄積エネルギーを負荷に放出するようにされているDC－DCコンバータによって達成される。

さらに、上記いずれの構成においても、フライホイール回路起動用回路（K）には、前記のインダクタンス（L）の一次側と前記のキャパシタ（C）の二次側との間に接続されるダイオード（D_2）と前記の第2のキャパシタ（C_1）との直列回路と、前記の第2のキャパシタ（C_1）の一次側と前記のキャパシタ（C）の二次側との間に接続され前記のインダクタンス（L）の一次側の電圧と前記の角形磁化特性を有するインダクタンス（SR）とによって制御され、その一次側は前記の第2のスイッチング手段（Q_1）の制御電極と接続されている第3のスイッチング手段（Q_2）とを有する回路が使用可能である。

〔作用〕

本発明に係るDC－DCコンバータは、電界効果トランジスタ等のスイッチング手段Q_1とダイオードD_1との並列回路と角形磁化特性を有するインダクタンスSR例えば可飽和リアクトルとの直列回路をもってフライホイール回路Fを構成し、これに、インダクタンス（L）の一次側とキャパシタ（C）の二次側との間に接続されるダイオード（D_2）と前記の第2のキャパシタ（C_1）との直列回路と、前記の第2のキャパシタ（C_1）の一次側と前記のキャパシタ（C）の二次側との間に接続され前記のインダクタンス（L）の一次側の電圧と前記の角形磁化特性を有するインダクタンス（SR）とによって制御され、その一次側は前記の第2のスイッチング手段（Q_1）の制御電極と接続されている第3のスイッチング手段（Q_2）とを有するフライホイール回路起動用回路Kを付加して、主回路のスイッチング手段Qが

ンスLに過渡的に蓄えられていたエネルギーとが放出されて、直流出力に引き続き供給される。

このとき、インダクタンスLの一次側（図にAをもって示す点）の電位が低下するので、ダイオードD_1と角形磁化特性を有するインダクタンスSR（本例においては可飽和リアクトル）とを介して電流が流れ始めるが、角形磁化特性を有するインダクタンスSRは瞬間的に大きなインダクタンスとして機能して逆方向電圧を発生するから、A点の電位は瞬間的に負電位となる。そのため、npnトランジスタQ_1は遮断し OFF、すでに充電されていた第2のキャパシタC_2の正電位が第2のスイッチング手段Q_2のゲートに印加されて、第2のスイッチング手段Q_2は閉路し ON、フライホイール回路Fが導通状態となり、インダクタンスL中に蓄えられていたエネルギーはこのフライホイール回路Fを介して放出される。そして、この状態は、npnトランジスタQ_1が閉路するまで持続される。

一方、角形磁化特性を有するインダクタンスSRは、僅少の電流の流入をもって飽和し、その後はインダクタンスとして機能しないので、フライホイール回路F中に多大な電力損失が発生することはない。

なお、スイッチング手段Qが ON 閉路している期間に、万一、第2のスイッチング手段Q_2が閉路するようなことがあっても、フライホイール回路FはダイオードD₁を介して導通状態に保持されるので、信頼性が高い。

また、抵抗R_1・R_2・R_3はいずれも電流制限用抵抗であり、回路動作に対して重大な意義は有しない。一方、ダイオードD_1は単なる保護手段であり、これも、回路動作に重大な影響を及ぼさない。

Tの期間が完了して、スイッチング手段Qが再び ON 閉路すると、当初の状態に復帰するが、この時、第2のスイッチング手段Q_2は、まだ ON 閉路状態にある。しかし、角形磁化特性を有するインダクタンスSRは、電流の流れる方向が逆転する際には大きなインダクタンス値をしめすため、角形磁化特性を有するインダクタンスSRの両端に電圧が発生し、A点の電位が上昇する。そして、その時にnpnトランジスタQ_1のベースに正電圧が印加され、npnトランジスタQ_1が閉路することによって、第2のスイッチング手段Q_2が開路することになる。したがって、npnトランジスタQ_1が閉路し、第2のスイッチング手段Q_2が開路するまでに、僅かな時間遅れが生じるが、その期間、第2のスイッチング手段Q_2には、角形磁化特性を有するインダクタンスSRの大きなインダクタンス値によって制限された僅かな電流しか流れないため、現実には、何の不利益もともなわない。

第1図に示す回路構成のDC－DCコンバータは、以上に説明したように、スイッチング手段Qの開閉路に自動的に追従して、フライホイール回路Fが不導通状態・導通状態相互間に移行し、フライホイール回路Fに順方向損失もともなわず、スイッチング手段Qの開閉に迅速に追従してフライホイール動作をなすことができる。

第2例

第3図参照

本例と第1例との相違は、スイッチング手段Qが閉路している期間開路して、フライホイール回路Fを構成する第2のスイッチング手段Q_2のゲート電位を負電位に保持して、この第2のスイッチング手段Q_2を開路させておき、スイッチング手段Qが開路している期間閉路して第2のキャパシタC_2の電位をフライホイール回路Fを構成する第2のスイッチング手段Q_2のゲートに与えて、これを閉路するスイッチング手段Q_3として、nチャンネルエンハンスメント型電界効果トランジスタが使用されており、これに関連して、いくらかのマイナーチェンジが施されているのみであり、基本的動作は全く同一である。

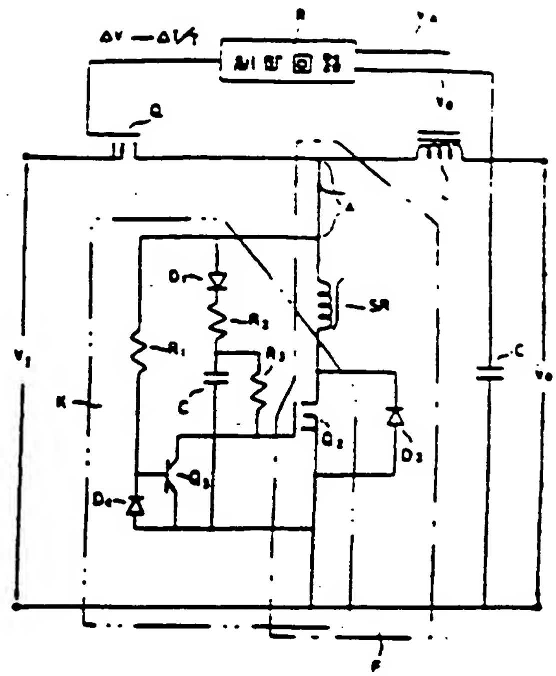
〔発明の効果〕

以上説明したとおり、本発明に係るDC－DCコンバータは、スイッチング手段とインダクタンスとキャパシタとの直列回路が、直流入力電源に

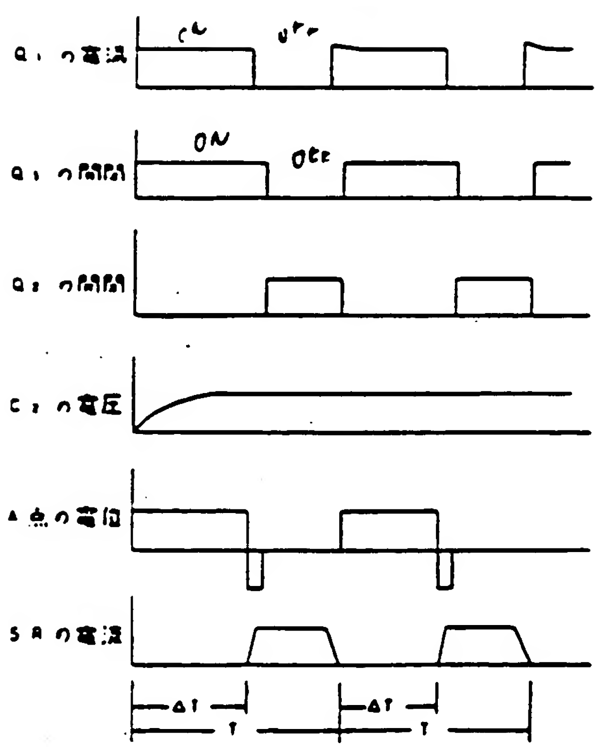
スタ。

代理人 弁理士 草川純一

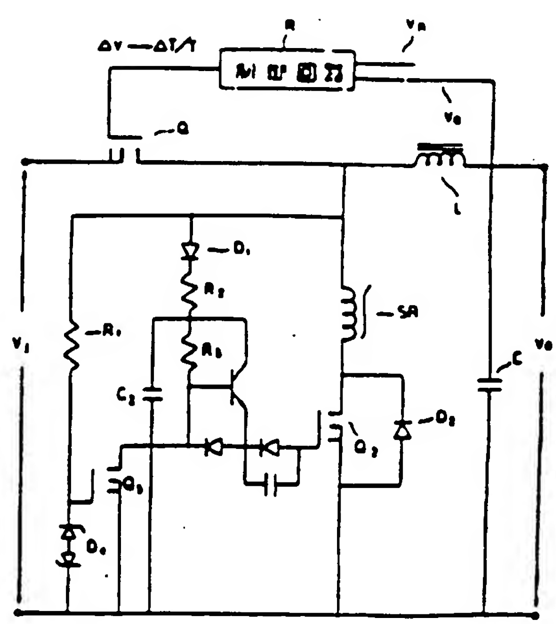
第 1 図



第 2 図



第 3 図



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